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Study D-I-B

STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

ECOLOGY OF REARING FISH

by

Dennis J. Hubartt

ALASKA DEPARTMENT OF FISH AND GAME

Ronald O. Skoog, Commissioner

SPORT FISH DIVISION

Rupert E. Andrews, Director

## TABLE OF CONTENTS

STUDY D-I    A STUDY OF LAND USE ACTIVITIES AND THEIR RELATIONSHIP TO THE SPORT FISH RESOURCES IN ALASKA	Page
--	------

Job. No.    D-I-A    Establishment of Guidelines for Protection of the  
Sport Fish resources During Land Use Activities  
By:    Dennis J. Hubartt

Abstract . . . . .	1
Background . . . . .	1
Recommendations . . . . .	2
Research . . . . .	2
Management . . . . .	2
Objectives . . . . .	3
Findings . . . . .	3
Interagency Activities . . . . .	3
Development of Field Techniques . . . . .	3
Literature Cited . . . . .	4

Job No.    D-I-B    Ecology of Rearing Fish  
By:    Dennis J. Hubartt

Abstract . . . . .	5
Background . . . . .	6
Recommendations . . . . .	6
Research . . . . .	6
Management . . . . .	10
Objectives . . . . .	10
Techniques Used . . . . .	10
Statistical Design . . . . .	10
Methods . . . . .	12
Findings . . . . .	13
Debris Removal Studies . . . . .	13
Logged and Unlogged Stream Surveys . . . . .	15
Rearing Dolly Varden in Montana Creek . . . . .	30
Summary . . . . .	33
Debris Removal Studies . . . . .	33
Logged and Unlogged Stream Surveys . . . . .	38
Rearing Dolly Varden in Montana Creek . . . . .	44
Literature Cited . . . . .	47

## LIST OF FIGURES

Figure 1.    Study Area, 1979 . . . . .	7
Figure 2.    Montana Creek Study Sites . . . . .	8
Figure 3.    Annual Estimates of the Numbers of Dolly Varden in Three Tributaries to Starrigavin Creek . . . . .	39

# TABLE OF CONTENTS (Cont'd.)

## LIST OF TABLES

	Page
Table 1. List of common names, scientific names and abbreviations	9
Table 2. Aquatic insects collected in Spring Pond Creek . . . . .	16
Table 3. Aquatic insects collected with a benthic sampler in unlogged tributaries to Kook Creek, June, 1979 . . . . .	19
Table 4. Aquatic insects collected with drift nets in unlogged and logged tributaries to Kook Creek, June, 1979 . . . . .	20
Table 5. Aquatic insects collected with a benthic sampler in the Crab Creek watershed, August, 1979 . . . . .	24
Table 6. Aquatic insects collected with drift nets in the Crab Creek watershed, August, 1979 . . . . .	25
Table 7. Aquatic insects collected with a benthic sampler in the Freshwater Bay area, September 1, 1979 . . . . .	28
Table 8. Aquatic insects collected with drift nets in the Freshwater Bay area, September 1, 1979 . . . . .	29
Table 9. Aquatic insects collected with a benthic sampler in the Pavlof River watershed, July 18, 1979 . . . . .	31
Table 10. Aquatic insects collected with drift nets in the Pavlof River watershed, July 18, 1979 . . . . .	32
Table 11. McGinnis Creek Tributary - Benthic . . . . .	34
Table 12. McGinnis Creek Tributary - Net Samples . . . . .	35
Table 13. McGinnis Creek - Drift Net Samples . . . . .	36
Table 14. Results of using three methods to quantify four habitat parameters . . . . .	37
Table 15. Summary of parameter values related to rearing Dolly Varden in small logged or unlogged streams . . . . .	40
Table 16. Summary of parameter values related to rearing coho salmon ( $\geq 55$ mm) in small logged and unlogged streams . . . . .	41
Table 17. Summary of Aquatic Insect Information Derived from Benthic Samples in logged and unlogged streams . . . . .	42
Table 18. Summary of the assessment of four habitat parameters in logged and unlogged streams . . . . .	43
Table 19. Summary of significant correlations between fish, insect and habitat parameters . . . . .	45



## RESEARCH PROJECT SEGMENT

State: ALASKA

Name: Sport Fish Investigations  
of Alaska

Project No.: F-9-12

Study No.: D-I

Study Title: A STUDY OF LAND USE ACTIVITIES  
AND THEIR RELATIONSHIP TO THE  
SPORT FISH RESOURCES IN ALASKA

Job No.: D-I-B

Job Title: Ecology of Rearing Fish

Period Covered: July 1, 1979 to June 30, 1980

## ABSTRACT

The job Ecology of Rearing Fish was involved in three areas of activity during this reporting period: 1) the effects of logging debris removal on the rearing salmonid environment, 2) short-term surveys of small logged and unlogged streams within the same areas, and 3) an assessment of the status of rearing Dolly Varden in the Montana Creek watershed.

Experimental removal of logging debris in Spring Pond Creek during 1976 resulted in an 80% decrease in the numbers of rearing Dolly Varden over a 2-year period. Annual monitoring since then has shown that the population has returned to near pre-treatment levels. Population levels in two nearby tributaries did not exhibit similar changes.

Surveys of three logged and four unlogged streams included estimating the numbers of rearing salmonids in sections of streams, recording and analyzing catch statistics and length data, collecting otoliths and weight data, sampling aquatic insect populations with benthic and drift samplers, collecting and analyzing data related to rearing salmonid habitat, and recording general information about the study sites. Although no consistent differences were found between small logged and unlogged streams, data analysis indicated that parameters related to rearing salmonids, aquatic insects, and rearing salmonid habitat could be quantified during short-term surveys, and introduced the possibility of establishing quantifiable relationships between rearing fish, aquatic insects and habitat parameters.

Concern about the decline of Dolly Varden populations in the Juneau area prompted the Land Use Project to study rearing salmonid and macrobenthos populations in Montana Creek to determine if poor freshwater productivity was related to the decline. Population levels of juvenile Dolly Varden and the density and community structure of salmonids in the system were found to be similar to other systems that had been studied previously.

## BACKGROUND

Early studies of the ecology of rearing fish in southeast Alaska identified problems related to land use activities and the need to develop techniques for quantifying parameters of stream ecosystems so that impacts of land use activities could be realistically evaluated. The major land use activity in Southeast was clearcut logging, and a major problem associated with this activity was the introduction of large amounts of organic debris into streams (see Reed and Elliott, 1972). Concurrent studies in Hood Bay on Admiralty Island demonstrated the importance of small streams, especially spring-fed streams, to the overwinter survival of rearing salmonid fishes (Armstrong and Elliott, 1972). In light of these studies the Sport Fish Division created the Job D-I-B, Ecology of Rearing Fish, under the Land Use Project.

The first year of this job was spent in the development of techniques for the estimation of numbers of rearing salmonids (Elliott and Reed, 1973). From 1974 until 1976 the job involved the study of distribution, movement, and abundance of rearing salmonids in three tributaries in a logged watershed.

Also studied was the diversity and relative abundance of aquatic insects in the same watershed. In 1976, one of the tributaries--Spring Pond Creek--was thoroughly cleaned of all organic debris that had been introduced during logging operations, and fish and insect studies were continued (see Elliott, 1976). Monitoring of fish and aquatic insects has continued until the present.

In 1977 the project received monies to conduct baseline studies on the Keta, Wilson and Blossom Rivers near the site of a proposed open pit molybdenum mine, and many of the techniques that had been developed previously were applied to those studies. A separate report covering this project, which continued through 1979, is being prepared.

The techniques for assessing rearing fish and aquatic insects have been continually modified and, hopefully, improved during the history of the job (see Hubartt, 1979). The current report includes: 1) continued efforts to monitor rearing salmonid population levels and to collect samples of aquatic insects in the Starrigavin watershed, 2) a first attempt at using the techniques to analyze differences in fish and aquatic insect populations and four habitat parameters in logged and unlogged streams within the same areas, and 3) the use of the techniques to assess the status of Dolly Varden populations in Montana Creek in conjunction with the development of methods for the assessment of four parameters associated with rearing salmonid habitat. The areas studied are shown in Figure 1. Figure 2 shows the study sites in the Montana Creek watershed. All species discussed in this report are listed in Table 1.

## RECOMMENDATIONS

### Research

1. Continue to monitor the effects of logging debris removal on juvenile salmonid and aquatic insect populations in small streams by:

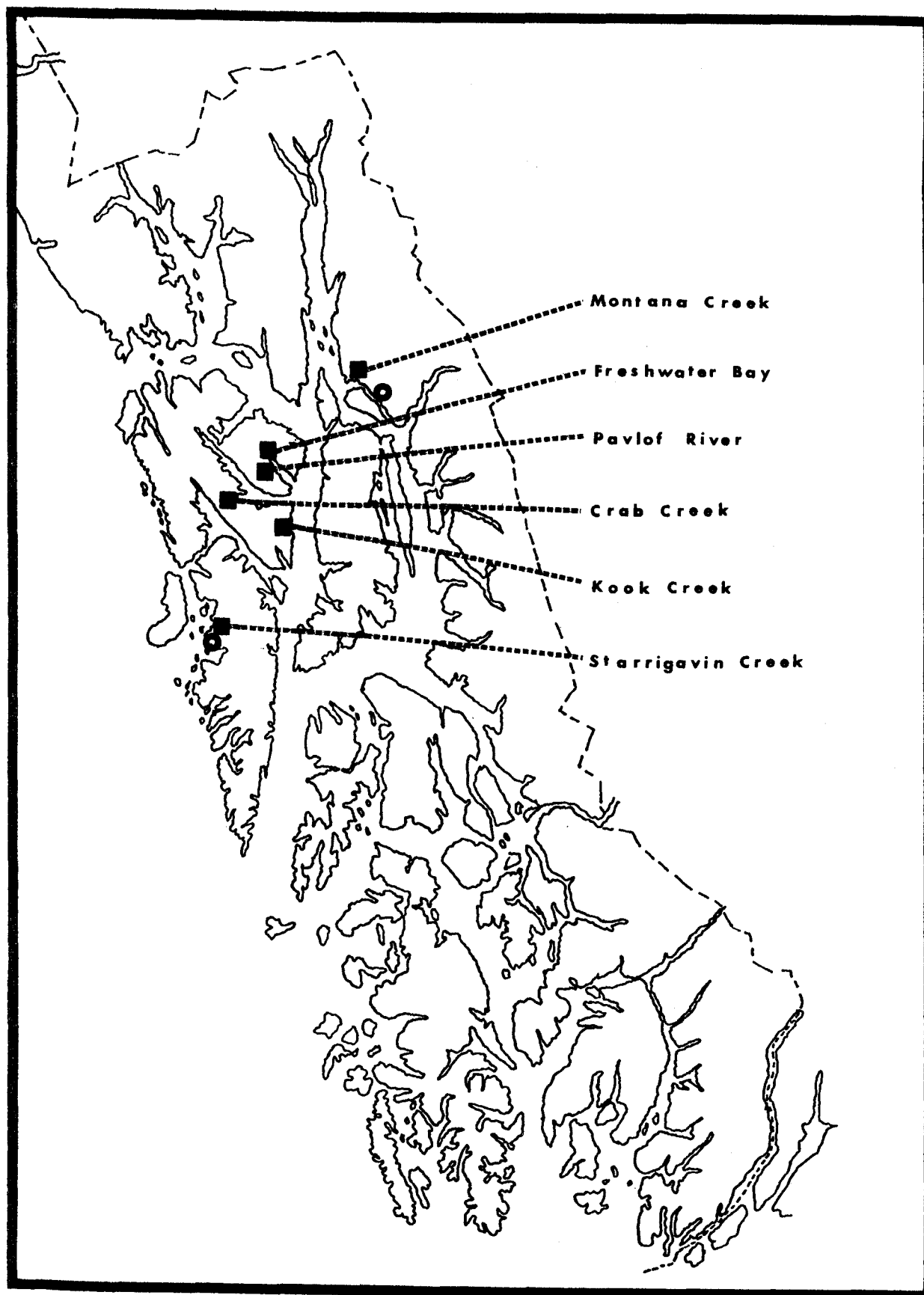
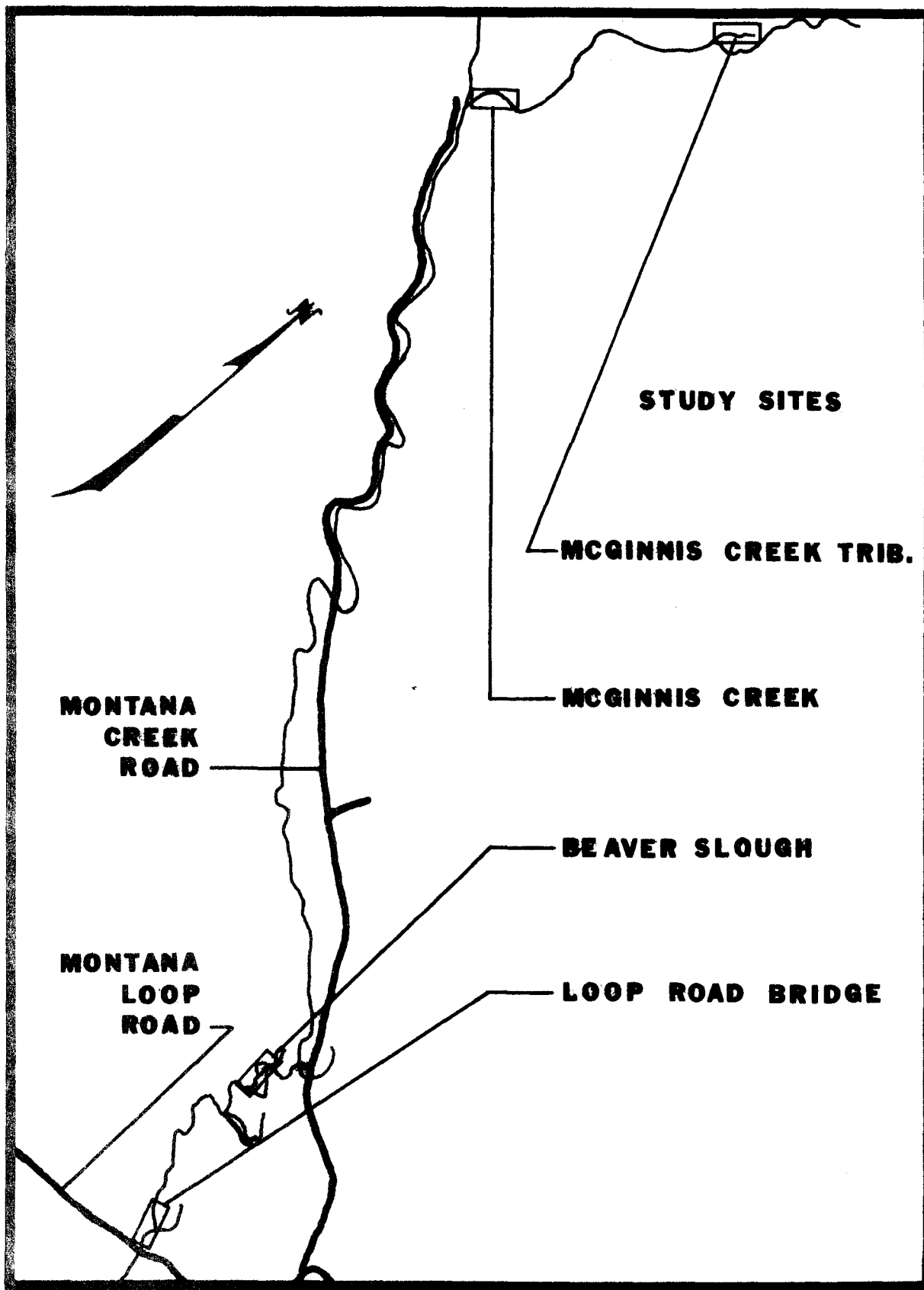


Figure 1. Study Areas, 1979.



**FIGURE 2. MONTANA CREEK STUDY SITES**



Table 1. List of common names, scientific names, and abbreviations.

Common Name	Scientific Name and Author	Abbreviation
Dolly Varden	<u>Salvelinus malma</u> (Walbaum)	DV
Coho salmon	<u>Oncorhynchus kisutch</u> (Walbaum)	SS
Chinook salmon	<u>Oncorhynchus tshawytscha</u> (Walbaum)	KS
Cutthroat trout	<u>Salmo clarki</u> Richardson	CT
Steelhead-Rainbow trout	<u>Salmo gairdneri</u> Richardson	RT
Sculpins	<u>Cottus</u> sp.	SSC

- a. Conducting systematic population estimates in the Starrigavin watershed to monitor changes in population size and structure,
  - b. Determining biomass, standing crop, species diversity and distribution of macrobenthos.
2. Determine the effects of logging on aquatic productivity by:
    - a. Assessing productivity levels in selected small watersheds in southeast Alaska that have not been impacted by logging activities.
    - b. Monitoring productivity levels in the same watersheds during and after logging activities.
    - c. Determining changes, if any, in aquatic productivity associated with logging activities and, if possible, establish the mechanisms by which changes are effected.
  3. Determine the overwinter survival of rearing salmonids in small tributaries of logged and unlogged watersheds.

#### Management

1. Continue to publish significant results gathered by this job and make thesis available to land managers.

#### OBJECTIVES

1. Continue to monitor the effects of debris removal in Spring Pond Creek.
2. Complete baseline data collection on the Keta, Wilson and Blossom watersheds.
3. Determine if differences in aquatic productivity occur in tributaries of logged and unlogged watersheds.
4. Determine the overwinter survival of rearing salmonids in small tributaries of logged and unlogged watersheds.
5. Determine the status of rearing Dolly Varden populations in the Montana Creek watersheds.

#### TECHNIQUES USED

##### Statistical Design

##### Assessment of Rearing Salmonids:

Five parameters related to rearing salmonids were quantified whenever possible in the current studies. These parameters were as follows; (1)

mean catch per unit of effort, (2) species composition, (3) numerical estimates, (4) density estimates and (5) mean lengths. Descriptions of the techniques and formulae used to quantify these parameters were presented in Hubartt (1979).

#### Assessment of Aquatic Insects:

Numbers of aquatic insects collected, percent composition, the Shannon-Weaver Diversity Index and Equitability were the parameters relating to aquatic insects that were quantified during the current studies. The Shannon-Weaver Diversity Index ( $\bar{d}$ ) is an index that summarizes the data on total numbers and total number of taxa. In the current study these data were derived from insects collected with a circular depletion sampler (Carle, 1976). The formula used to calculate  $\bar{d}$  is as follows:

$$\bar{d} = \frac{C}{N} (N \log N - \sum n_i \log n_i)$$

where;

C = a constant = 3.321928

N = the total number of individuals

$n_i$  = the total number of individuals in the  $i$ th taxon.

In general, this index reflects the diversity of aquatic insect communities and is related to water quality. Values less than one may indicate polluted waters, while values between 3 and 4 are expected for unpolluted waters. A more detailed discussion and additional references may be found in Weber (1973).

Equitability ( $e$ ) compares the number of taxa present with the expected number of taxa based on the value of  $\bar{d}$  and is calculated according to the following formula:

$$e = \frac{S'}{S}$$

where;

S = the number of taxa in the sample

$S'$  = the tabulated value dependent on  $\bar{d}$

A table (from Lloyd and Ghelardi, 1964) for finding the value of  $S'$ , as well as a discussion of Equitability may be found in Weber (1973). Usually the value of  $e$  will range from 0 to 1 with values less than 0.5 indicating possibly polluted waters.

#### Assessment of Habitat Parameters:

Four habitat parameters related to the environment inhabited by rearing salmonids were chosen for study. These parameters were (1) pools, (2) instream velocity barriers, (3) undercut banks, and (4) overhead cover. The problem was to identify a practical and reasonably accurate method whereby these parameters could be quantified within a relatively short period of time. A 304.8 m section of a tributary to McGinnis Creek near

Juneau was chosen as a study site, and three methods were employed to quantify the four parameters: the aerial method, the visual method, and the transect method (described in detail in the methods section). All three methods were applied to the same study site, and in the case of the aerial and visual methods, the number of sample units were varied; while in the case of the transect method the number of transects were varied. In all cases the mean value of the parameter considered was obtained by summing the values from each sample unit or transect and dividing by the number of sample units or transects. Thus, the mean and standard deviation for each of the parameter values was calculated by using the standard formulae for mean and standard deviation. The values obtained by applying the aerial method to a large number of sample units (i.e. 50 sections within the 304.8 m study site) were felt to be the most accurate and were used as the yardstick with which the other values were compared, except in the case of overhead cover where the visual method was used. In order to compare values obtained from the different methods, all values were converted to percentages.

#### Methods

##### Assessment of Rearing Salmonids:

Minnow traps baited with preserved salmon eggs were used to collect rearing salmonids following the methods described in Hubartt (1979). All sampling was conducted in study sites that were 304.8 m in length. Whenever possible fish movement into or out of the study site was restricted by placing 1/4-inch mesh beach seines across the stream above and below the site.

##### Assessment of Aquatic Insects:

Benthic and drift net samples were collected in the same study sites that were used for the assessment of rearing salmonids. Benthic samples were obtained by using a circular depletion sampler (CDS) and procedures described by Carle (1976). Three CDS samples were taken within each study site, specimens were sorted in the field and placed in 95% ethyl alcohol, and insects were later identified to the lowest taxa feasible. Drift net samples were obtained by placing two drift nets in each study stream for 24 hour intervals. Drift net samples were processed in the same manner as benthic samples.

##### Assessment of Habitat Parameters:

Aerial Method. The aerial method involved measuring the rectangular dimensions of the parameter of interest with a tape measure. This was done within each sample unit and the total area occupied by a particular parameter was recorded. The widths of the upper and lower boundaries of each sample unit were recorded and during the McGinnis Creek studies sample unit lengths were set at measured distances of either 6.1 or 15.24 m. During the logging studies the sample unit lengths were always 15.24 m. Thus the area of each sample unit could be calculated, as well as the percentage of the sample unit that was occupied by a particular parameter. For example, if sample unit #15 was 15.24 m in length and the widths of the upper and lower boundaries were 3.7 m and 2.7 m, respectively; the surface area of the sample unit was calculated to be 72m<sup>2</sup> by using the formula for finding

the area of a trapezoid. If the sum of the area occupied by pools was 18.6 m<sup>2</sup>, then the percentage of pools in that sample unit was calculated to be 25.8%. The percentages from each sample unit were then summed and the mean and standard deviation for a particular parameter was calculated using the standard formulae. Only two of the four parameters studied were evaluated using this procedure. These were pools and instream velocity barriers. The following definitions were used to identify there parameters in the stream:

Pools - any area of the stream with flows less than 30 cm/sec.

Instream Velocity Barriers - any organic or inorganic material in the stream causing a noticable reduction in stream flow.

Definitions used to identify undercut banks and overhead cover were as follows:

Undercut Banks - any area along the stream margin with water flowing underneath the bank.

Overhead Cover - all material directly above (i.e. perpendicular to) the water surface of the stream.

The procedure used to evaluate undercut banks when using the aerial method was different in that the percentage of undercut banks in each sample unit was calculated by comparing the measured length of the stream margin to the measured length of undercut banks contained within the stream margin. This method was used during the logging studies. Overhead cover was not evaluated while using the aerial method.

Visual Method. The visual method examined each sample unit visually and then qualitatively estimated the percentage of the area that was occupied by each of the parameters described above. The percentage of undercut banks occupying the stream margin was visually estimated. During the logging studies the visual method was used to obtain percentage values for pools, instream velocity barriers, and overhead cover.

Transect Method. The transect method was applied to three parameters - pools, instream velocity barriers, and overhead cover. Transect lines were defined as the upstream boundary lines of the sample units used in the aerial and visual methods and, hence, were spaced at either 6.1 or 15.24 meter intervals. The percentage value of a parameter was calculated by comparing the total length of the transect line (i.e. the stream width at that point) with the length of the line that intersected the parameter. It was necessary to visually estimate this length in the case of overhead cover. The ratio of the parameter length to the transect line length times 100 yielded a percentage value of a parameter for each transect. These values were then summed and the means and standard deviation was calculated using the standard formulae.

## FINDINGS

### Debris Removal Studies

## Population Estimates of Rearing Salmonids:

Spring Pond Creek. The rearing salmonid population was sampled in Spring Pond Creek July 9 and July 10, 1979 and on October 1 and October 2, 1979. During the July trapping period the means for catch per unit-effort of Dolly Varden were .014 DV/min and .011 DV/min using a total of 41 minnow traps. The catches were 125 DV and 92 DV respectively. Also a few coho salmon were captured -five SS and seven SS, respectively. The estimated number of Dolly Varden in Spring Pond Creek was 1,057 with a 95% confidence interval from 646 to 2,325. A total of 124 Dolly Varden were measured on July 9, 1979 and had a mean length of 66.3 mm with a standard deviation of 16.3 mm, and 92 DV were measured on 7/10/79 and had a mean length of 66.8 mm with a standard deviation of 13.6 mm.

During the October trapping period the means for catch per unit-effort of Dolly Varden was .041 DV/min and .028 DV/min using a total of 31 minnow traps and the catches were 253 DV and 160 DV, respectively. The means for catch per unit-effort of coho salmon (>55 mm) were .007 SS/min and .006 SS/min and the catches were 42 SS and 40 SS. Also, nine coho fry were captured. The estimated number of Dolly Varden was 974 with a 95% confidence interval from 757 to 1,319 and of coho salmon (>55 mm) was 220 with a 95% confidence interval from 126 to 441. A total of 253 Dolly Varden were measured on October 1, 1979 and had a mean length of 71.4 mm with a standard deviation of 20.2 mm and 42 coho salmon (>55 mm) were measured and had a mean length of 71.9 mm with a standard deviation of 14.8 mm. On October 2, 1979, 161 Dolly Varden were measured and had a mean length of 67.2 mm with a standard deviation of 14.5 mm, and 35 coho salmon were measured and had a mean length of 66.5 mm and a standard deviation of 10.1 mm.

Skunk Cabbage Creek. The rearing salmonid population was sampled in Skunk Cabbage Creek July 12 and 13, and on September 25 and 26, 1979. During the July trapping period the means for catch per unit-effort of Dolly Varden were .048 DV/min and .045 DV/min and the catches were 264 DV and 181 DV, respectively. The means for catch per unit-effort of coho salmon (>55 mm) were .023 SS/min and .017 SS/min and the catches were 138 SS and 71 SS. In addition, 115 coho fry (<55 mm) were captured. The estimated number of Dolly Varden was 412 with a 95% confidence interval from 374 to 468, and the estimated number of coho salmon (>55 mm) was 209 with a 95% confidence interval from 182 to 257. A total of 264 Dolly Varden were measured on July 12, 1979 and had a mean length of 80.3 mm with a standard deviation of 16.9 mm, and 138 coho salmon (>55 mm) were measured and had a mean length of 74.1 mm with a standard deviation of 10.0 mm. A total of 181 Dolly Varden were measured on July 13, 1979 and had a mean length of 77.9 mm with a standard deviation of 16.9 mm, and 71 coho salmon (>55 mm) were measured and had a mean length of 72.1 mm with a standard deviation of 9.0 mm.

During the September trapping period the means for catch per unit-effort of Dolly Varden were .036 DV/min and .060 DV/min and the catches were 137 DV and 190 DV, respectively. The means for catch per unit-effort of coho salmon (>55 mm) were .033 SS/min and .062 SS/min and the catches were 108 SS and 185 SS, respectively. In addition, 267 coho fry (<55 mm) were captured. The estimated number of Dolly Varden was 371 with a 95% confidence interval from 314 to 462, and the estimated number of coho salmon (>55 mm) was 317 with a 95% confidence interval from 263 to 398. A total

of 135 Dolly Varden were measured on September 25 and had a mean length of 77.9 mm with a standard deviation of 18.0 mm, and 98 coho salmon (>55 mm) were measured and had a mean length of 78.0 mm with a standard deviation of 11.5 mm. On September 26, 1979, 120 Dolly Varden were measured and had a mean length of 73.8 mm with a standard deviation of 16.7 mm, and 102 coho salmon (>55 mm) were measured and had a mean length of 75.5 mm with a standard deviation of 12.2 mm.

Control Creek. The rearing salmonid population in Control Creek was sampled on July 11 and 12, 1979 and on September 26 and 27, 1979. During the July trapping period the means for catch per unit-effort of Dolly Varden were .067 DV/min and .066 DV/min and the catches were 299 DV and 257 DV, respectively. The means for catch per unit-effort of coho salmon (>55 mm) were .011 SS/min and .012 SS/min, and the catches were 53 SS and 47 SS, respectively. The estimated number of Dolly Varden was 697 with a 95% confidence interval from 609 to 815, and the estimated numbers of coho salmon was 118 with a 95% confidence interval from 89 to 173. A total of 299 Dolly Varden were measured on July 11, 1979 and had a mean length of 76.1 mm with a standard deviation of 17.0 mm, and 53 coho salmon were measured and had a mean length of 73.6 mm with a standard deviation of 6.5 mm. Only July 12, 1979 257 Dolly Varden were measured and had a mean length of 74.7 mm with a standard deviation of 16.9 mm, and 43 coho salmon were measured and had a mean length of 72.5 mm with a standard deviation of 7.6 mm.

During the September trapping period the mean catch per unit-effort of Dolly Varden was .044 DV/min and .083 DV/min, and the catches were 215 DV and 233 DV, respectively. The mean catch per unit-effort of coho salmon was .016 SS/min and .031 SS/min, and the catches were 83 SS and 87 SS, respectively. In addition, two coho fry (> 55 mm) were captured. The estimated number of Dolly Varden was 790 with a 95% confidence interval from 648 to 1,011, and the estimated number of coho salmon (>55 mm) was 284 with a 95% confidence interval from 211 to 435. On September 25, 1979, 206 Dolly Varden were measured and had a mean length of 73.4 mm with a standard deviation of 16.3 mm, and 81 coho (>55 mm) were measured and had a mean length of 78.3 mm with a standard deviation of 9.2 mm. On September 26, 1979, 169 Dolly Varden were measured and had a mean length of 76.4 with a standard deviation of 15.6 mm, and 61 coho salmon (>55 mm) were measured and had a mean length of 75.8 mm with a standard deviation of 9.5 mm.

#### Aquatic Insect Sampling:

Spring Pond Creek. A total of 1,050 aquatic insects from 18 taxa were collected in six Hess samples on July 10, 1979, and 329 individuals from 13 taxa were collected in 10 Surber samples on October 15 and 16, 1979. Table 2 lists the taxa, numbers collected, and percent of the sample for the two periods. The Shannon-Weaver Diversity Index ( $\bar{d}$ ) derived from the July samples was 1.4 and Equitability (e) was 0.2, and  $\bar{d}$  for the October samples was 2.3 and e was 0.5.

#### Logged and Unlogged Stream Surveys

Kook Creek (112-12-025). Location - Lat 57°59'00", 24 kilometers southeast of Tenakee near the east coast of Chicagof Island.

Table 2. Aquatic insects collected in Spring Pond Creek, 1979

Taxa	July 10, 1979 (6 Hess Samples)		October 15-16, 1979 (10 Surber Samples)	
	Number Collected	% of Sample	Number Collected	% of Sample
Chironomidae	833	79.3	168	51.1
<u>Alloperla</u> spp.	81	7.7	67	20.4
<u>Ephemerella</u> (S.) spp.	26	2.5		
<u>Ameletus</u> spp.	23	2.2		
<u>Dicronata</u> spp.	20	1.9	8	2.4
<u>Limnephilidae</u>	16	1.5	1	0.3
<u>Leuctra</u>	8	0.7		
<u>Ceratopogonidae</u>	8	0.7	1	0.3
<u>Baetis bicaudatus</u>	6	0.6	19	5.8
<u>Paraleptophlebia</u> spp.	6	0.6	1	0.3
<u>Rhyacophila</u> spp.	6	0.6	11	3.3
<u>Tipulidae</u>	5	0.5		
<u>Cinygmula</u> spp.	3	0.3	31	9.5
<u>Ephemerella gran-</u> <u>dis</u>	3	0.3		
<u>E. coloradensis</u>	2	0.2		
<u>Coleoptera</u>	2	0.2		
<u>Brachycentridae</u>	1	0.1		
<u>Empididae</u>	1	0.1		
<u>Ecclisomyia</u> spp.			11	3.3
<u>Hydracarina</u> spp.			8	2.4
<u>Ephemerella spinifera</u>			2	0.6
<u>E. (S.) tibialis</u>			1	0.3
TOTAL	1,050	100.0	329	100.0



Description. Kook Creek is the major inlet stream to Kook Lake and is approximately 16 kilometers in length. Study sites were located on two tributaries to this stream. The first site was on an unlogged tributary about 1.6 km upstream from Kook Lake. This tributary was about 460 m long with an average width of 1.5 m and an average depth of 15 cm. The substrate consisted of small to large cobble (110-150 mm) and the water velocity was slow ( $< 30$  cm/sec). The stream originated in a muskeg and the water color was light brown. During the survey the weather ranged from sunny to light rain, the air temperature varied around  $14^{\circ}\text{C}$ , and the water temperature was  $6^{\circ}\text{C}$ . The second study site was on a logged tributary about 2.4 km upstream from Kook Lake on the left fork of Kook Creek. This tributary was also about 460 m long with an average width of 1.9 m and an average depth of 30 cm. About three-quarters of this tributary was within a clearcut with the lower portion (about 152 m from the mainstream to the edge of the clearcut) being relatively undisturbed. Logging had been conducted in the Kook Lake area in 1973 and 1974, and by 1979 bridges and culverts had been removed from the spur roads and logging had been discontinued. The substrate in the logged tributary consisted of sand to large cobble (2-200 mm) and the water velocity was slow ( $< 30$  cm/sec). Water temperature was from 7 to  $8^{\circ}\text{C}$ .

Barriers. None of either tributary.

Species Present. Dolly Varden, rainbow trout, cutthroat trout, pink salmon, chum salmon, red salmon and coho salmon.

Species Composition and Abundance. Rearing fish were captured in the unlogged tributary on June 27 and 28, 1979. The means for catch per unit-effort of Dolly Varden were .022 DV/min and .012 DV/min and the catches were 70 DV and 37 DV respectively. The catches of coho salmon were 10 SS and 6 SS, respectively and the catches of cutthroat trout were seven CT and five CT, respectively. Species composition as derived from these catches was 79.3% Dolly Varden, 11.9% coho salmon and 8.8% cutthroat trout.

The area sampled was 304.8 m in length and widths were measured at 15.24 m intervals. The estimated surface area was  $475\text{ m}^2$ . The estimated number of Dolly Varden was 180 with a 95% confidence interval from 128 to 300. Insufficient numbers of rearing coho salmon and cutthroat trout were present to obtain estimates of their abundance. The density estimate for Dolly Varden was  $0.38\text{ DV/m}^2$ .

During the June 27, 1979 trapping period 70 Dolly Varden were measured and had a mean length of 71.6 mm with a standard deviation of 15.2 mm. A total of 35 Dolly Varden were measured during the June 28, 1979 trapping period and had a mean length of 64.6 mm with a standard deviation of 16.3 mm.

Rearing fish were captured in the logged tributary on June 26 and 27, 1979. The means for catch per unit-effort of Dolly Varden were .019 DV/min and .014 DV/min and the catches were 73 DV and 56 DV respectively. The means for catch per unit-effort of cutthroat trout were .004 CT/min and .001 CT/min and the catches were 15 CT and five CT respectively. The catches of coho salmon were one SS and six SS, and the catches of rainbow trout were eight RT and no RT, respectively. Species composition as derived from these catches was 78.7% Dolly Varden, 12.2% cutthroat trout, 4.9% rainbow trout and 4.3% coho salmon.

The area sampled was 304.8 m in length and widths were measured at 15.24 m intervals. The estimated surface area was 596.7 m<sup>2</sup>. The estimated number of Dolly Varden was 234 with a 95% confidence interval from 169 to 383. Insufficient numbers of rearing coho salmon, cutthroat trout, and rainbow trout were present to obtain estimates of their abundance. The density estimate for Dolly Varden was 0.39 DV/m<sup>2</sup>.

During the June 26, 1979 trapping period 73 Dolly Varden were measured and had a mean length of 76.5 mm with a standard deviation of 21.5 mm. A total of 56 Dolly Varden were measured during the June 27, 1979 trapping period and had a mean length of 74.2 mm with a standard deviation of 15.6 mm.

Aquatic Insects - Species Composition. A total of 464 aquatic insects from 19 taxa were collected with a benthic sampler from three areas in the unlogged tributary on June 27, 1979 and 385 individuals from 20 taxa were collected from three areas in the logged tributary on June 28, 1979. The Shannon-Weaver Diversity Index ( $\bar{d}$ ) for the unlogged tributary was 3.5 and for the logged tributary was 3.3. Equitability ( $e$ ) for the two tributaries was 0.9 and 0.7, respectively. Table 3 lists the numbers collected and percent composition for each taxa collected in the two tributaries.

Two drift nets were set for 24 hour intervals on both tributaries and numbers collected and percent of the sample are listed in Table 4.

Habitat Assessment. Diagramatic mapping of nineteen 15.24 m sections within the 304.8 m study area in the unlogged tributary provided estimates of the amounts of four habitat parameters. Pools constituted 32.1% of the study area, instream velocity barriers covered 4.2% of the area, overhead cover was 86.3%, and undercut banks were present along 75.4% of the stream margins.

In the logged tributary pools constituted 10.3% of the area, instream velocity barriers covered 15.0% of the area, overhead cover amounted to 13.9%, and 11.1% of the stream margin consisted of undercut banks.

Crab Creek (112-43-002). Location - Lat 57°43'36", long 135°21'54". 12 km southwest of Tenakee on the south side of Tenakee Inlet on Chichagof Island.

Description. Crab Creek is the largest watershed entering Crab Bay and is about 10.4 km long. Two study sites were established in this watershed. An unlogged site was located on a small unbranch of the mainstream about 6.4 km from the mouth of Crab Creek. This section of Crab Creek had an average width of 4.8 m and an average depth of 30 cm. The substrate consisted of sand to large cobble (2-200 mm) and water velocities were around 30 cm/sec. The water color at the start of the survey was light brown but steady rain gradually changed it to a dark brown. The air temperature was around 14°C and the water temperature was 8°C. The second study site was on a logged tributary about 5.6 km from the mouth of Crab Creek. This tributary flowed along the edge of a clearcut and had an average width of 3.8 m and an average depth of 25 cm. The substrate consisted of gravel to large cobble (30-200 mm) and water velocities were greater than 30 cm/sec. Water temperature on this tributary was 12°C. Some logging was being conducted at the time of the survey, but not in the vicinity of either of the study areas.

Table 3. Aquatic insects collected with a benthic sampler in unlogged and logged tributaries to Kook Creek, June, 1979.

Taxa	Unlogged Tributary (6/27/79)		Logged Tributary (6/28/79)	
	Number Collected	% of Sample	Number Collected	% of Sample
<u>Alloperla</u> spp.	82	17.7	64	16.6
<u>Nemouridae</u>	59	12.7	17	4.4
<u>Chironomidae</u>	56	12.1	76	19.7
<u>Baetis bicaudatus</u>	53	11.4	5	1.3
<u>Cinygmula</u> spp.	44	9.5	54	14.0
<u>Paraleptophlebia</u> spp.	38	8.2	46	11.9
<u>Limnephilidae</u>	30	6.5	15	3.9
<u>Dicronata</u> spp.	27	5.8	23	6.0
<u>Leuctra</u>	23	4.9	23	6.0
<u>Ameletus</u> spp.	19	4.1	23	6.0
<u>Acari</u>	13	2.8	13	3.4
<u>Glossosoma</u> spp.	5	1.1		
<u>Rhyacophila</u> spp.	4	0.9	4	1.0
<u>Tipulidae</u>	4	0.9		
<u>Epeorus</u> spp.			6	1.6
<u>Ephemerella doddsi</u>			4	1.0
<u>Ceratopogonidae</u>			4	1.0
<u>Psychoglypha</u> spp.	3	0.6		
<u>Empididae</u>	1	0.2	2	0.5
<u>Kathroperla</u> spp.			2	0.5
<u>Ephemerella coloradensis</u>			2	0.5
<u>Lepidostoma</u>	1	0.2	1	0.3
<u>Ditiscidae</u>	1	0.2		
<u>Ephemerella</u> spp.	1	0.2		
<u>E. (Serratella) spp.</u>			1	0.3
TOTAL	464	100.0	385	100.0

Table 4. Aquatic insects collected with drift nets in unlogged and logged tributaries to Kook Creek, June, 1979.

Taxa	Unlogged tributary (6/27/79)						Kook Creek					
	Number Collected			Percent of Sample			Number Collected			Percent of Sample		
	Larvae	Pupae	Adults	Larvae	Pupae	Adults	Larvae	Pupae	Adults	Larvae	Pupae	Adults
Baetis	514			64.7			20			15.2		
<u>bicaudatus</u>												
Limnephilidae	29	5		3.6	0.6							
Chironomidae	17		3	2.1		0.4	13			9.8		
Ephemerella spp.	13			1.6			1			0.8		
Leuctra	12		2	1.5		0.3	5			3.7		
Capnia spp.	12			1.5								
Cinygmula spp.	10			1.3			2			1.5		
Dicronata spp.	10			1.3			1			0.8		
Paraleptophlebia	6			0.8			5			3.7		
<u>spp.</u>												
Simuliidae	6	1		0.8	0.1							
Ephemerella (S.)	3			0.4			13			9.8		
<u>spp.</u>												
Nemoura spp.	2			0.3								
Epeorus (I.)							5			3.7		
<u>albertae</u>												
Epeorus spp.	1			0.1								
Trichoptera	1		1	0.1	0.1							
Lepidostomatidae	1			0.1								
Dixidae	1			0.1								
Muscidae	1			0.1								
Lepidoptera	2			0.3								
Bibionidae			87		10.9				56			42.4

Table 4. (Cont.) Aquatic insects collected with drift nets in unlogged and logged tributaries to Kook Creek, June, 1979.

Taxa	Unlogged tributary (6/27/79)						Kook Creek					
	Number Collected			Percent of Sample			Number Collected			Percent of Sample		
	Larvae	Pupae	Adults	Larvae	Pupae	Adults	Larvae	Pupae	Adults	Larvae	Pupae	Adults
Diptera			30		3.8				1			0.8
Collembola			9		1.1							
Coleoptera			5		0.6							
Hydracarina			6		0.8				1			0.8
Nemoura (P.) <u>decepta</u>			3		0.4							
Tipulidae			1		0.1							
Dermaptera			1		0.1							
<u>Ameletus</u> spp.							1			0.8		
<u>Baetis</u> spp.							1			0.8		
<u>Glossosoma</u> spp.							1			0.8		
Ceratapogonidae							1			0.8		
<u>Dixa</u> (D.) spp.							1			0.8		
Hemiptera									3			2.2
Ephemoptera									1			0.8
Total	641	6	148	80.7	18.6	0.7	70	0	62	53.0	0.0	47.0

Barriers. A 4 m falls is present approximately 9.6 km from the mouth of Crab Creek.

Species Present. Dolly Varden, cutthroat trout, rainbow trout, coho salmon, pink salmon, chum salmon, and cottids.

Fish Species Composition and Abundance. Rearing fish were captured in the unlogged anabranch on July 31 and August 1, 1979. The means for catch per unit-effort of Dolly Varden were .034 DV/min and .042 DV/min, and the catches were 160 DV and 169 DV, respectively. The means for catch per unit-effort of coho salmon were .042 SS/min and .052 SS/min, and the catches were 212 SS and 210 SS, respectively. Also 18 and 11 coho salmon fry ( $\leq 55$  mm in length) were captured. The catches of cutthroat trout were four CT and three CT, the catches of rainbow trout were four RT and three RT, and the catches of cottids were 33 SSC and 11 SSC respectively. Species composition as derived from these catches was 39.3% DV, 53.8% SS, 0.8% CT, 0.8% RT, and 5.3% SC.

The area sampled was 304.8 m in length and widths were measured at 15.24 m intervals. The estimated surface area was  $596 \text{ m}^2$ . The estimated number of Dolly Varden was 380 with a 95% confidence interval from 322 to 464. The estimated number of rearing coho salmon ( $> 55$  mm) was 681 with a 95% confidence interval from 562 to 848. Insufficient numbers of cutthroat and rainbow trout were captured to obtain estimates of their abundance. The density estimate for Dolly Varden was  $0.64 \text{ DV/m}^2$  and the density estimate for coho salmon was  $1.14 \text{ SS/m}^2$ .

During the July 31, 1979 trapping period, 160 Dolly Varden were measured and had a mean length of 77.2 mm with a standard deviation of 16.8 mm, and 212 coho salmon ( $> 55$  mm) were measured and had a mean length of 67.3 mm with a standard deviation of 12.1 mm. During the August 1, 1979 trapping period, 169 Dolly Varden were measured and had a mean length of 74.3 mm with a standard deviation of 16.7 mm, and 210 coho salmon ( $> 55$  mm) were measured and had a mean length of 68.3 mm with a standard deviation of 7.7 mm.

Rearing fish were captured in the logged tributary on August 2 and August 3, 1979. The means for catch per unit-effort of Dolly Varden were .009 DV/min and .012 DV/min, and the catches were 50 DV and 48 DV, respectively. The means for catch per unit-effort of coho salmon were 0.046 SS/min and 0.047 SS/min, and the catches were 254 SS and 176 SS respectively. The catches of cutthroat trout were 0 and one, and the catches of rainbow trout were seven and three respectively. No cottids were captured in this area. Species composition as derived from these catches was 18.2% DV, 79.8% SS, 0.2% CT, and 1.8% RT.

The area sampled was 304.8 m in length and widths were measured at 15.24 m intervals. The estimated surface area was  $468 \text{ m}^2$ . The estimated number of Dolly Varden was 278 with a 95% confidence interval from 167 to 625. The estimated number of coho salmon ( $> 55$  mm) was 1,118 with a 95% confidence interval from 865 to 1,528. Insufficient numbers of cutthroat and rainbow trout were captured to obtain an estimate of their numbers. The density estimate for Dolly Varden was  $0.59 \text{ DV/m}^2$  and for coho salmon was  $2.39 \text{ SS/m}^2$ .

During the August 2, 1979 trapping period 49 Dolly Varden were measured and had a mean length of 84.6 mm with a standard deviation of 27.4 mm, and 263 coho salmon (> 55 mm) were measured and had a mean length of 75.5 mm with a standard deviation of 7.8 mm. During the August 3, 1979 trapping period, 48 Dolly Varden were captured and had a mean length of 76.4 mm with a standard deviation of 15.7 mm, and 178 coho salmon (> 55 mm) were measured and had a mean length of 73.5 mm with a standard deviation of 8.5 mm.

Aquatic Insects - Species Composition and Abundance. A total of 413 aquatic insects from 17 taxa were collected with a benthic sampler from three areas in the unlogged anabranch on August 2, 1979, and 116 individuals from 13 taxa were collected from three areas in the logged tributary on August 3, 1979. The Shannon-Weaver Diversity Index ( $\bar{d}$ ) for the unlogged site was 2.7 and for the logged tributary was 2.7 as well. Equitability for the two sites was 0.5 and 0.7 respectively. Table 5 lists the numbers collected and percent composition for each taxa collected in the two areas.

Two drift nets were set for 24 hour intervals in each of the streams. Table 6 lists the numbers collected and percent of the sample for each taxa collected.

Habitat Assessment. Diagrammatic mapping of twenty 15.24 m sections within the 304.8 m study area in the unlogged anabranch provided estimates of the amounts of four habitat parameters. Pools constituted 56.8% of the study area, instream velocity barriers covered 21.8% of the area, overhead cover was 39.3%, and undercut banks were present along 19.6% of the stream margin.

In the logged tributary, pools constituted 58.8% of the area, instream velocity barriers covered 24.3% of the area, overhead cover was 44.7%, and 27.5% of the stream margin consisted of undercut banks.

Freshwater Bay (near 112-50-032). Location - Lat 57°57'57", long 135°13'13" at the head of Freshwater Bay on Chichagof Island.

Description. An unlogged stream draining into a bight of Freshwater Bay southwest of the mouth of stream #112-50-032 was selected as a study site. This stream had a moderate to steep gradient, a cobble and boulder substrate, an abundant growth of aquatic moss, and light brown water of low turbidity. The average width was 1.6 m and an average depth of 9 cm. The stream drained an area of mature forest with light underbrush of blueberry and devil's club. The water temperature during the survey was 12°C and the weather was foggy with light rain.

A logged stream, located 90 m northwest of the mouth of stream #112-50-032, was selected as the second study site. This stream was less than 1 km in length with an average width of 1.5 m and an average depth of 8 cm. Most of the drainage area was contained within the boundaries of a 1967 clear-cut. The stream bed had a silt and detritus substrate with logging debris forming many instream velocity barriers, often completely covering the stream. Overhanging brush formed a complete canopy over the study area except for the uppermost portion and made access very difficult. The stream was slow moving and clear and, because of a 3-week dry period prior to the survey, the water level was low. The weather during the time of the survey was cloudy with intermittent rain and the water temperature was 11°C.

Table 5. Aquatic insects collected with a benthic sampler in the Crab Creek watershed, August, 1979.

Crab Creek Benthic Samples				
Taxa	Unlogged Anabranh (8/2/79)		Logged Tributary (8/3/79)	
	Number Collected	Percent Composition	Number Collected	Percent Composition
Chironomidae	154	37.3	22	19.0
<u>Alloperla</u> spp.	77	18.6	49	42.3
<u>Leuctra</u>	57	13.8	13	11.2
<u>Ameletus</u> spp.	51	12.3	5	4.3
<u>Empididae</u>	29	7.0	7	6.0
<u>Dicronata</u> spp.	16	3.9	2	1.7
<u>Kathroperla</u> spp.	8	1.9		
<u>Nemoura</u>	5	1.2	2	1.7
<u>Capnia</u> spp.	3	0.7		
<u>Hemerodromia</u>	3	0.7		
<u>Plecoptera</u>	2	0.6		
<u>Limnephilidae</u>	2	0.6	1	0.9
<u>Rhyacophila</u> spp.	2	0.6		
<u>Ephemerella</u> (S.) spp.	1	0.2	2	1.7
<u>Baetis</u> spp.	1	0.2		
<u>Hesparconupa</u> spp.	1	0.2		
<u>Ceratopogonidae</u>	1	0.2	8	6.9
<u>Cinygmula</u> spp.			2	1.7
L. <u>Psychoglypha</u> sub			2	1.7
<u>Paraleptophlebia</u> spp.			1	0.9
TOTAL	413	100.0	116	100.0



Table 6. Aquatic insects collected with drift nets in the Crab Creek watershed, August, 1979.

Drift Net Samples													
		Unlogged Anabranh (8/2/79)						Logged Tributary (8/3/79)					
		Number Collected			Percent of Sample			Number Collected			Percent of Sample		
Taxa	Larvae	Pupae	Adults	Larvae	Pupae	Adults	Larvae	Pupae	Adults	Larvae	Pupae	Adults	Adults
Chironomidae	26			31.4			9	1		75.1	8.3		
Alloperla spp.	26			31.4									
Rhyacophila spp.	5			6.0									
Ameletus spp.	4			4.8									
Dicronata spp.	4			4.8									
Cinygmula spp.	3			3.6									
Ephemerella (S.) spp.	3			3.6									
Baetis spp.	1			1.2									
Baetis bicaudatus	1			1.2									
Epeorus spp.	1			1.2									
Capnia spp.	2			2.4									
Limnephilidae	1			1.2									
Diptera		1	1		1.2	1.2							
Paraloptophlebia spp.	1			1.2									
Nemoura spp.	1			1.2									
Collembola	2			2.4									
Hemiptera										1			8.3
Thysanoptera										1			8.3
Total	81	1	1	97.6	1.2	1.2	9	1	2	75.1	8.3		16.6

Barriers. None.

Species Present. Dolly Varden, cutthroat trout, coho salmon and cottids.

Fish Species Composition and Abundance. Rearing fish were captured in the unlogged stream on August 30 and August 31, 1979. The means for catch per unit-effort of Dolly Varden were .015 DV/min and .011 DV/min and the catches were 42 DV and 38 DV, respectively. The means for catch per unit-effort of coho salmon (> 55 mm) were .007 SS/min and .006 SS/min and the catches were 23 SS and 21 SS respectively. Also a three coho salmon fry (> 55 mm) were captured. The catches of cutthroat trout were 17 CT and 12 CT and of cottids were seven SC and four SC, respectively. Species composition as derived from these catches was 45.2% Dolly Varden, 26.6% coho salmon, 22.0% cutthroat trout and 6.2% cottids.

The area sampled was 304.8 m in length and widths were measured at 15.24 m intervals. The estimated surface area was 189 m<sup>2</sup>. The estimated number of Dolly Varden was 76 with a 95% confidence interval from 58 to 105. The estimated number of coho salmon (> 55 mm) was 48 with a 95% confidence interval from 33 to 88. The density estimate for Dolly Varden was 0.40 DV/m<sup>2</sup> and for coho salmon was 0.25 SS/m<sup>2</sup>.

During the August 30, 1979 trapping period 42 Dolly Varden were measured and had a mean length of 79.8 mm with a standard deviation of 10.7 mm, and 24 coho salmon (> 55 mm) were measured and had a mean length of 78.3 mm with a standard deviation of 8.3 mm. During the August 30 trapping period 38 Dolly Varden were measured and had a mean length of 81.3 mm with a standard deviation of 10.4 mm, and 21 coho salmon were measured and had a mean length of 80.4 mm with a standard deviation of 8.2 mm.

Rearing fish were captured in the logged stream on August 28 and August 29, 1979. The means for catch per unit-effort of coho salmon (> 55 mm) were .014 SS/min and .004 SS/min and the catches were 62 SS and 14 SS, respectively. Also 11 coho salmon fry were captured. The catches of Dolly Varden were five DV and one DV, the catches of cutthroat trout were 22 CT and four CT, and the catches of cottids were 21 SC and 12 SC, respectively. Species composition as derived from these catches was 4.0% Dolly Varden, 57.2% coho salmon, 17.1% cutthroat trout and 21.7% cottids.

The area sampled was 304.8 m in length and widths were measured at 15.24 m intervals. The estimated surface area was 155 m<sup>2</sup>. The estimated number of coho salmon was 95 with a 95% confidence interval from 73 to 158. Insufficient numbers of Dolly Varden and cutthroat trout were captured to obtain estimates of their abundance. The density estimate for coho salmon was 0.61 SS/m<sup>2</sup>.

During the August 28, 1979 trapping period 62 coho salmon (> 55 mm) were measured and had a mean length of 79.4 mm with a standard deviation of 8.7 mm. A total of 22 cutthroat trout were measured and had a mean length of 76.4 mm with a standard deviation of 9.3 mm.

Aquatic Insects - Species Composition and Abundance. A total of 254 aquatic insects from 23 taxa were collected with a benthic sampler from three locations in the unlogged stream on September 1, 1979. The Shannon-

Weaver Diversity Index ( $\bar{d}$ ) was 3.3 and Equitability was 0.6. Because of the large amounts of silt and logging debris present in the logged stream, use of the benthic samplers was impractical. Table 7 lists the numbers collected and percent composition, for each taxa collected in the unlogged stream.

Two drift nets were set for 24 hour intervals in each of the streams. Table 8 lists the numbers collected and percent of the sample for each taxa collected.

Habitat Assessment. Diagrammatic mapping of twenty 15.24 m sections within the 304.8 m study area in the unlogged stream at the head of Freshwater Bay provided estimates of the amounts of four habitat parameters. Pools constituted 66.5% of the study area, instream velocity barriers covered 77.5% of the area, overhead cover was 80.0%, and undercut banks were present along 27.8% of the stream margin.

In the logged stream pools constituted 91.0% of the area, instream velocity barriers covered 80.6% of the area, overhead cover was 0.0%, and 90.5% of the stream margin consisted of undercut banks.

Pavlof River (112-50-010). Location - Lat 57°50'30", long 135°02'18". Drains into Pavlof Harbor near the outlet of Freshwater Bay on the east side of Chichagof Island.

Description. An unlogged tributary to the Pavlof River approximately 0.4 km upstream from Pavlof Lake was selected as a study site. This tributary was approximately 2.4 km in length with an average width of 6 m and an average depth of 15 cm. The substrate consisted of coarse gravel and rocks up to 20 cm in diameter and the gradient was moderate. The water color was light brown, water temperature was 12°C, and the weather was cloudy and rainy during the time of the survey. Logging and roadbuilding were being conducted in the Pavlof River drainage, but all activities were being conducted upriver from the study area. The upper portions of the tributary studied were scheduled to be logged in the near future.

Barriers. None on the tributary studied.

Species Present. Dolly Varden, steelhead trout, cutthroat trout, pink salmon, chum salmon, red salmon, coho salmon, and stickleback.

Fish Species Composition and Abundance. Rearing fish were captured on July 17 and July 18, 1979. The means for catch per unit-effort for Dolly Varden were .044 DV/min and .033 DV and the catches were 124 DV and 130 DV, respectively. The means for catch per unit-effort for coho salmon (> 55 mm) were .014 SS/min and .009 SS/min and the catches were 42 SS and 30 SS, respectively. In addition, six coho salmon fry (> 55 mm) were captured. The means for catch per unit-effort of cutthroat trout were .004 CT/min and .005 CT/min and the catches were 15 CT and 12 CT, respectively. The species composition as derived from these catches was 70.8% Dolly Varden, 21.7% coho salmon and 7.5% cutthroat trout.

The area sampled was 304.8 m in length and widths were measured at 15.24 m intervals. The estimated surface area was 1,800m<sup>2</sup>. The estimated number

Table 7. Aquatic insects collected with a benthic sampler in the Freshwater Bay area, September 1, 1979.

Freshwater Bay Benthic Samples Unlogged Stream		
Taxa	Number Collected	Per cent Composition
<u>Alloperla spp.</u>	82	32.3
<u>Paraleptophlebia</u> <u>spp.</u>	51	20.1
<u>Chironomidae</u>	27	10.6
<u>Leuctra augustra</u>	24	9.4
<u>Leuctra spp.</u>	9	3.5
<u>Nemoura spp.</u>	7	2.8
<u>Rhyacophila spp.</u>	7	2.8
<u>Empididae</u>	5	2.0
<u>Ceratopogonidae</u>	5	2.0
<u>Cinygmula spp.</u>	4	1.6
<u>Ephemerella (S.)</u> <u>tibialis</u>	4	1.6
<u>Paraleptophlebia</u> <u>debilis</u>	3	1.2
<u>Nemoura (Z.) spp.</u>	3	1.2
<u>Limnophilidae</u>	3	1.2
<u>Brachycentridae</u>	3	1.2
<u>Micrasema spp.</u>	3	1.2
<u>Dicronata spp.</u>	3	1.2
<u>Atherix spp.</u>	3	1.2
<u>Hydracarina</u>	3	1.2
<u>Paraleptophlebia</u> <u>memonalis</u>	2	0.8
<u>Atherix variegata</u>	1	0.3
<u>Ephemerella aurivillii</u>	1	0.3
<u>Capnia spp.</u>	1	0.3
Total	254	100.0

Table 8. Aquatic insects collected with drift nets in the Freshwater Bay area, September 1, 1979.

Freshwater Bay Drift Nets				
Unlogged Stream			Logged Stream	
Taxa	Number Collected	Per cent Composition	Number Collected	Per cent Composition
Chironomidae	18	69.3	23	30.3
Dixidae			10	13.2
Leuctra			9	11.9
<u>Baetis Bicaudatus</u>			8	10.5
<u>Nemoura (Zapada) spp.</u>	2	7.7	7	9.2
<u>Limnophilidae</u>	2	7.7	6	7.9
<u>Paraleptophlebia heteronea</u>			3	4.0
Hydracarina	2	7.7	2	2.6
Simuliidae			2	2.6
Collembola	1	3.8	2	2.6
<u>Baetis tricaudatus</u>			1	1.3
<u>Ephemerella (S.) tibialis</u>			1	1.3
Coleoptera	1	3.8		
Hymenoptera			2	2.6
Total	26	100.0	76	100.0

of Dolly Varden was 372 with a 95% confidence interval from 298 to 496. The estimated number of coho salmon was 103 with a 95% confidence interval from 70 to 190. Insufficient numbers of cutthroat trout were captured to obtain an estimate of their abundance. The density<sub>2</sub> estimate for Dolly Varden was 0.12 DV/m<sup>2</sup> and for coho salmon was 0.06 SS/m<sup>2</sup>.

During the July 17, 1979 trapping period 124 Dolly Varden were measured and had a mean length of 76.5 mm with a standard deviation of 13.1 mm. A total of 43 coho salmon (> 55 mm) were measured and had a mean length of 74.9 mm with a standard deviation of 8.1 mm. During the July 18, 1979 trapping period 130 Dolly Varden were measured and had a mean length of 78.3 mm with a standard deviation of 13.6 mm, and 26 coho salmon were measured and had a mean length of 77.2 mm with a standard deviation of 9.6 mm.

Aquatic Insects - Species Composition and Abundance. A total of 334 aquatic insects from 19 taxa were collected with a benthic sampler from three areas within the study site on July 18, 1979. The Shannon-Weaver Diversity Index was 3.1 and Equitability was 0.7. Table 9 lists the numbers collected and percent composition for each taxa collected.

Two drift nets were set for 24 hour intervals on the study stream, and numbers collected and percent composition are listed in Table 10.

Habitat Assessment. Diagrammatic mapping of twenty 15.24 m sections within the 304.8 m study area provided estimates of the amount of four habitat parameters. Pools constituted 26.3% of the study area. Instream velocity barriers covered 13.3% of the area. Overhead cover was 29.0%. Undercut banks were present along 42.5% of the stream margin.

#### Rearing Dolly Varden in Montana Creek

##### Population Estimates of Rearing Salmonids:

Rearing fish were trapped in four areas of the Montana Creek watershed during the summer of 1979. These areas included a section of the main-stream near the Mendenhall Loop Road bridge, a beaver slough area, a section of McGinnis Creek near its confluence with Montana Creek, and a tributary to McGinnis Creek. These areas are indicated in Figure 2.

Rearing fish were trapped in the Loop Road section on August 8 and August 9, 1979 and the means for catch per unit-effort of Dolly Varden were .006 DV/min and .002 DV/min and the catches were 38 DV and 12 DV, respectively. The means for catch per unit-effort of coho salmon (> 55 mm) were .012 SS/min and .013 SS/min and the catches were 73 SS and 63 SS, respectively. In addition, 48 coho salmon fry (> 55 mm) and 45 cottids were captured. The species composition in this area as derived from these catches was 17.9% DV, 66.0% SS, and 16.1% cottids. Insufficient numbers of marked fish were recaptured to obtain estimates of rearing fish abundance.

Rearing fish were trapped in the beaver slough area on two occasions. On May 16, 1979, four Dolly Varden and seven coho salmon were captured yielding mean catch per unit-efforts of .001 DV/min and .002 SS/min. A low water temperature of 3.5°C contributed to the low catch rates. Rearing fish were again trapped in this area on July 25 and 26, 1979. The means

Table 9. Aquatic insects collected with a benthic sampler in the Pavlof River watershed, July 18, 1979.

---

Pavlof River Benthic samples		
Unlogged Tributary		
Taxa	Number Collected	Percent Composition
<hr/>		
<u>Ameletus spp.</u>	97	29.0
<u>Cinygmula spp.</u>	58	17.4
Chironomidae	56	16.7
Empididae	33	9.9
<u>Alloperla spp.</u>	25	7.5
Ceratopogonidae	11	3.3
Paraleptophlebia	9	2.7
<u>Ephemevella (D.)</u>	8	2.4
<u>coloradensis</u>		
<u>Rhyacophila spp.</u>	7	2.1
<u>Baetis bicaudatus</u>	6	1.8
Acari	6	1.8
Elmidae	4	1.2
<u>Ephemerella (D.) spp.</u>	3	0.9
<u>Ephemerella spp.</u>	2	0.6
Plecoptera	2	0.6
Nemouridae	2	0.6
Tipulidae	2	0.6
<u>Dicronata spp.</u>	1	0.6
Leuctra	1	0.3
Total	333	100.0

---

Table 10. Aquatic insects collected with drift nets in the Pavlof River watershed, July 18, 1979.

Pavlof River Drift Net Samples						
Unlogged Tributary						
Taxa	Number Collected			Per cent Composition		
	Larvae	Pupae	Adults	Larvae	Pupae	Adults
<u>Ameletus spp.</u>	34			23.7		
<u>Chironomidae</u>	29	4	6	20.3	2.8	4.2
<u>Baetis bican-</u> <u>datus</u>	11		5	7.7		3.5
<u>Cinygmula spp.</u>	9			6.3		
<u>Ephemerella (D)</u> <u>spp.</u>	6			4.2		
<u>E. (D.) Colora-</u> <u>densis</u>	5			3.5		
<u>Paraleptophlebia</u>	5			3.5		
<u>Alloperla spp.</u>	4			2.8		
<u>Empididae</u>	2			1.4		
<u>Leuctra</u>	1			0.7		
<u>Ceratopogonidae</u>	1			0.7		
<u>Onocosmoecus spp.</u>	1			0.7		
<u>Dicronata spp.</u>	1			0.7		
<u>Lepidoptera</u>	1			0.7		
<u>Amphizoa</u>	1		2	0.7		1.4
<u>Coleoptera</u>			4			2.8
<u>Hymenoptera</u>			4			2.8
<u>Ephemoptera</u>			1			0.7
<u>Diptera</u>			1			0.7
<u>Pnoctepredea</u>			1			0.7
<u>Nemouridae</u>			1			0.7
<u>Limnophilidae</u>			1			0.7
<u>Aphidae</u>			2			1.4
Total	111	4	28	77.6	2.8	19.6



for catch per unit-effort of Dolly Varden were .036 DV/min and .013 DV/min, and the catches were 159 DV and 49 DV, respectively. The means for catch per unit-effort of coho salmon (> 55 mm) were .024 SS/min and .009 SS/min, and the catches were 103 SS and 36 SS, respectively. In addition 112 coho salmon fry (> 55 mm) and 18 cottids were captured. Species composition as derived from these catches was 43.6% DV, 52.6% SS, and 3.8% SSC. The estimated number of Dolly Varden was 533 with a 95% confidence interval from 364 to 889, and the estimated number of coho salmon (> 55 mm) was 428 with a 95% confidence interval from 257 to 962.

Rearing fish were trapped in McGinnis Creek near its confluence with Montana Creek on June 6 and 7, 1979. The means for catch per unit-effort of Dolly Varden were .001 DV/min and .001 DV/min and the catches were 31 DV and three DV, respectively. The means for catch per unit-effort of coho salmon were .003 SS/min and .001 SS/min and the catches were 47 SS and one SS, respectively. In addition, one rainbow trout was captured.

Rearing fish were trapped in a tributary to McGinnis Creek on July 24 and 25, 1979. The means for catch per unit-effort of Dolly Varden were .033 DV/min and .035 DV/min, and the catches were 122 DV and 122 DV, respectively. The means for catch per unit-effort of coho salmon (> 55 mm) were both less than .001 SS/min, and the catches were four SS and two SS, respectively. In addition, 18 coho salmon fry (> 55 mm) and five cutthroat trout were captured. The species composition as derived from these catches was 89.4% DV, 8.8% SS and 1.8% CT. The estimated number of Dolly Varden was 890 with a 95% confidence interval from 605 to 1,513.

#### Aquatic Insect Sampling:

A total of 307 aquatic insects from 14 taxa were collected with a benthic sampler in the tributary to McGinnis Creek on July 26, 1979. The numbers collected and percent composition are listed in Table 11. The Shannon-Weaver Diversity Index as derived from these samples was 2.7 and Equitability was 0.6. A total of 32 insects from 12 taxa were collected with two drift net sets for 24 hour intervals near the mouth of the McGinnis Creek tributary on July 27, 1979. The numbers collected and percent of the sample are presented in Table 12. Drift nets were also set for 24 hour intervals near the confluence of McGinnis Creek on June 5, 1979. A total of 664 insects from 23 taxa were collected, and the numbers collected and percent of the sample are listed in Table 13.

#### Habitat Assessment:

The three methods described previously - the aerial method, the visual method and the transect method - were employed in a tributary to McGinnis Creek (see Figure 2) to determine which method or combination of methods could be used during short term surveys. Table 14 shows the results of using the three methods in 50-6.1 m sections or intervals, and 20-15.24 m sections or intervals and also indicates which of these methods were used during the logged and unlogged stream surveys.

#### Summary

#### Debris Removal Studies

Table 11. McGinnis Creek Tributary - Benthic Samples (July 26, 1979)

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<u>Taxa</u>	<u>Number Collected</u>	<u>Percent Composition</u>
Empididae	114	37.1
<u>Alloperla spp.</u>	61	19.9
Chironomidae	42	13.7
<u>Cinygmula spp.</u>	32	10.4
<u>Paraleptophlebia spp.</u>	20	6.5
<u>Dicronata spp.</u>	8	2.6
<u>Ameletus spp.</u>	6	2.0
<u>Baetis bicaudatus</u>	6	2.0
Limnephilidae	5	1.6
<u>Rhyacophila spp.</u>	5	1.6
Trichoptera	4	1.3
<u>Ephemerella (D.) doddsi</u>	2	0.7
<u>Ephemerella (D) spp.</u>	1	0.3
<u>Hesperoconopa spp.</u>	1	0.3
TOTAL	307	100.0

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Table 12. McGinnis Creek Tributary - Drift Net Samples (July 27, 1979)

<u>Taxa</u>	<u>Number Collected</u>		<u>Percent of Sample</u>	
	<u>Larvae</u>	<u>Adults</u>	<u>Larvae</u>	<u>Adults</u>
Chironomidae	15		47.0	
Baetis bicaudatus	3		9.4	
Alloperla spp.	2	1	6.3	3.1
Dicronata spp.	2		6.3	
Cinygmula spp.	1		3.1	
Epeorus spp.	1		3.1	
Limnephilidae	1		3.1	
Paraleptophlebia spp.	1		3.1	
Rhyacophila spp.	1	1	3.1	3.1
Staphylinidae		1		3.1
Coleoptera		1		3.1
Hymenoptera		1		3.1
TOTAL	27	5	84.5	15.5

Table 13. McGinnis Creek - Drift Net Samples (June 5, 1979)

<u>Taxa</u>	<u>Number Collected</u>			<u>Percent of Sample</u>		
	<u>Larvae</u>	<u>Pupae</u>	<u>Adults</u>	<u>Larvae</u>	<u>Pupae</u>	<u>Adults</u>
<u>Baetis bicaudatus</u>	285		1	42.9		0.2
Chironomidae	107	32	23	16.1	4.8	3.5
<u>Epeorus spp.</u>	56			8.4		
<u>Cinygmula spp.</u>	50			7.5		
<u>Alloperla spp.</u>	30			4.5		
Nemouridae	12			1.8		
<u>Ameletus spp.</u>	9			1.4		
<u>Nemoura (Z.) spp.</u>	7			1.0		
<u>Ephemerella (D.) spp.</u>	6			0.9		
Tipulidae	5			0.8		
<u>Epeorus (I.) albertae</u>	3			0.4		
<u>Ephemerella (D.) coloradensis</u>	3			0.4		
Leuctra	3			0.4		
Simuliidae	3			0.4		
Limnephilidae	2			0.3		
<u>Dicronata spp.</u>	2			0.3		
Pericoma	2			0.3		
Kathroperla	1			0.2		
Trichoptera	1			0.2		
Dermaptera	1			0.2		
Diptera			18			2.7
Ephemoptera			1			0.2
Staphylinidae			1			0.2
TOTAL	588	32	44	88.4	4.8	6.8

Table 14. Results of using three methods to quantify four habitat parameters.

	(50 - 6.1 meter sections)			(20 - 15.24 meter sections)		
	Areal Method	Visual Method	Transect Method	Areal Method	Visual Method	Transect Method
% Pools						
Mean	23.24	27.60	25.39	<u>11.75</u>	23.95*	25.00
Standard Deviation	25.93	26.94	33.12	10.90	24.82	28.55
% Instream Velocity barriers						
Mean	10.08	----	7.69	5.56	<u>16.60*</u>	10.52
Standard Deviation	11.92	----	10.39	8.03	12.44	12.54
% Undercut Banks						
Mean	7.42	----	----	7.60*	7.85	----
Standard Deviation	13.12	----	----	12.78	13.51*	----
% Overhead Cover						
Mean	----	30.60	----	----	27.95	<u>49.29</u>
Standard Deviation	----	23.88	----	----	20.39	32.07

\* Methods used during the logging studies:

Note: Underlined values are significantly different (at the 95% level) from the values obtained by applying the areal method (visual method in the case of overhead cover) to 50 - 6.1 meter sections.

Estimates of the numbers of rearing salmonids in Spring Pond Creek and Skunk Cabbage Creek were taken periodically during each year from 1973 until the present and in Control Creek from 1975 until the present. Figure 3 compares the combined seasonal estimates of numbers of Dolly Varden from each year in these three tributaries to Starrigavan Creek near Sitka, Alaska.

The numbers of rearing Dolly Varden in Skunk Cabbage Creek; a run-off stream that was cleared of debris in 1972 and which also contains a population of rearing coho salmon; have remained fairly constant during the course of the study.

Spring Pond Creek; a spring-fed stream from which all logging debris were removed in 1976 and which contained only Dolly Varden; exhibited a large decline in the numbers of Dolly Varden for 2 years following debris removal activities with a return to near pre-treatment levels by 1979. The October, 1979, estimates also indicated the presence of over 200 rearing coho salmon.

Control Creek; a spring-fed stream which still contains large amounts of logging debris and populations of both Dolly Varden and coho salmon; exhibited fluctuations in numbers of rearing Dolly Varden since estimates were begun in 1975.

Population estimates of rearing salmonids and sampling of aquatic insects will continue for one more field season. When these data have been analysed and compared with previous information an attempt will be made to summarize and publish the results of the debris removal study.

#### Logged and Unlogged Stream Surveys

The studies in logged and unlogged streams were conducted for a number of reasons. One of these was to determine if differences between small logged and unlogged streams within the same watershed could be quantified using short-term stream survey techniques. Tables 15, 16, 17 and 18 summarize the values of various parameters related to rearing Dolly Varden, rearing coho salmon, aquatic insects, and habitat parameters, respectively. The only statistically significant differences (at the 95% level or greater) between logged and unlogged study sites that were detected during the current study were as follows:

1. Mean catch per unit-effort for Dolly Varden was greater at the unlogged site at Crab Creek and Freshwater Bay.
2. Mean catch per unit-effort for coho salmon was lower at the unlogged site at Freshwater Bay.
3. Mean lengths of Dolly Varden were lower in the unlogged site at Kook Creek.
4. Mean lengths of coho salmon were lower at the unlogged site at Crab Creek.

FIGURE 3. ANNUAL ESTIMATES OF THE NUMBERS OF DOLLY VARDEN IN THREE TRIBUTARIES TO STARRIGAVIN CREEK, SITKA, ALASKA.

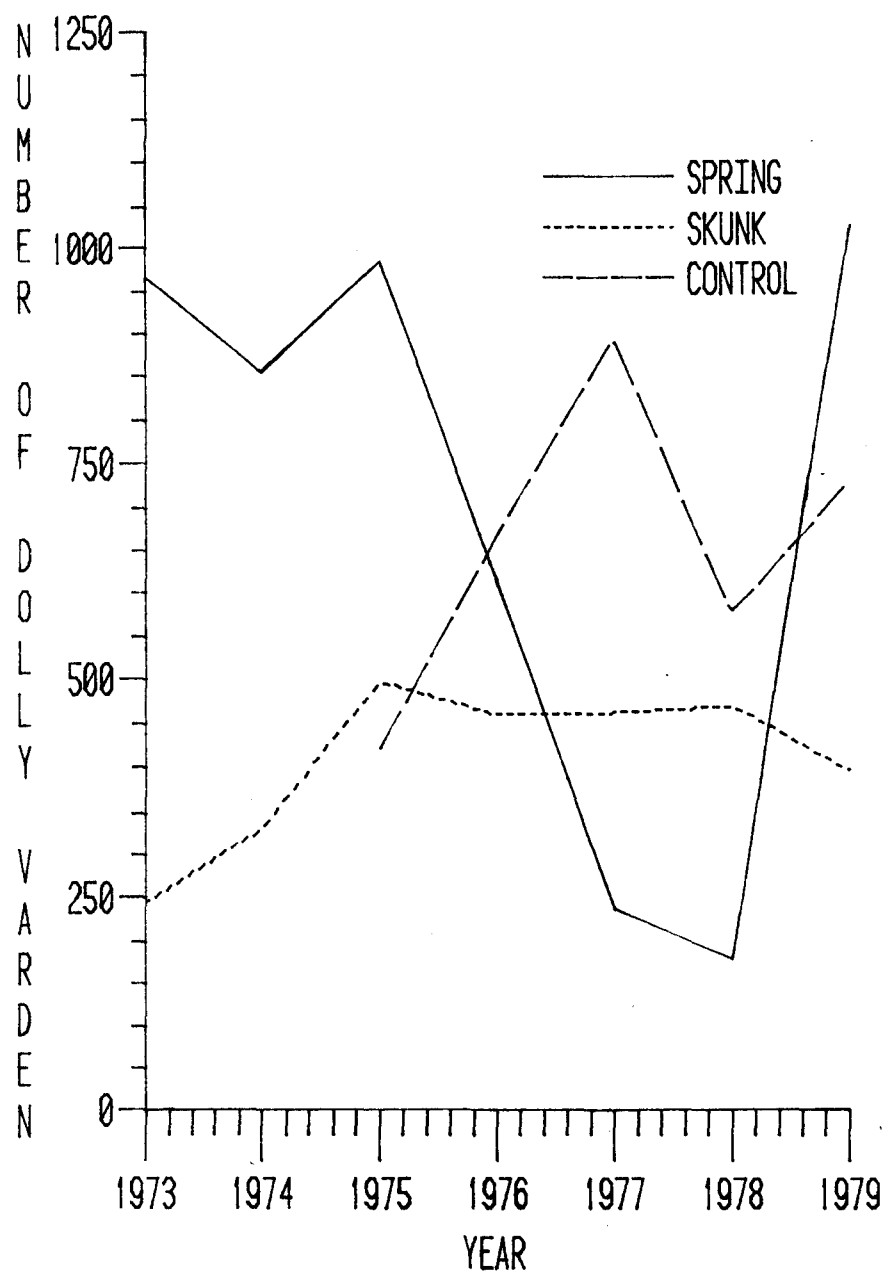


Table 15. Summary of parameter values related to rearing Dolly Varden in small logged and unlogged streams - 1979.

Location	Mean Catch per unit-effort (DV/min)	Total Catch	Numerical Estimate	Density Estimate (DV/m <sup>2</sup> )	Mean Length (mm)
Kook Creek (unlogged)	.022	107	180	0.38	68.8
Kook Creek (logged)	.019	129	234	0.39	75.7
Crab Creek (unlogged)	.034	329	380	0.64	75.7
Crab Creek (logged)	.009	98	278	0.59	80.5
Freshwater Bay (unlogged)	.015	80	76	0.39	80.6
Freshwater Bay (logged)	.001	6	---	0.04*	85.8**
Pavlof River (unlogged)	.044	254	372	0.21	77.4

\* Total catch divided by surface area

\*\* Small sample (n = 6)



Table 16. Summary of parameter values related to rearing coho salmon ( $\geq 55$  mm) in small logged and unlogged streams - 1979.

Location	Mean Catch per unit-effort (SS/min.)	Total Catch	Numerical Estimate	Density Estimate (SS/m <sup>2</sup> )	Mean Length (mm)
Kook Creek (unlogged)	.001	6	---	0.01*	70.3**
Kook Creek (logged)	.001	7	---	0.01*	67.9**
Crab Creek (unlogged)	.042	422	681	1.14	67.8
Crab Creek (logged)	.046	438	1118	2.39	74.7
Freshwater Bay (unlogged)	.007	76	48	0.25	79.3
Freshwater Bay (logged)	.014	44	95	0.61	79.1
Pavlof River (unlogged)	.014	72	103	0.06	75.8

\* Total catch  $\div$  surface area

\*\* Small sample size

Table 17. Summary of Aquatic Insect Information Derived from Benthic Samples in logged and unlogged streams.

	Total Number of Insects	Total Number of Taxa	$\bar{d}$	e
Kook Creek (unlogged)	464	19	3.5	0.9
Kook Creek (logged)	385	20	3.3	0.7
Crab Creek (unlogged)	413	17	2.7	0.5
Crab Creek (logged)	116	13	2.7	0.7
Freshwater Bay (unlogged)	254	23	3.3	0.6
Freshwater Bay (logged)	N.D.	N.D.	N.D.	N.D.
Pavlof River (unlogged)	334	19	3.1	0.7

$\bar{d}$  = Shannon-Weaver Diversity Index

e = Equitability

N.D. = No Data

Table 18. Summary of the assessment of four habitat parameters in logged and unlogged streams.

	Mean Percent Pools	Mean Percent Instream Velocity Barriers	Mean Percent Undercut Banks	Mean Percent Overhead Cover
Kook Creek (unlogged)	32.1	4.2	75.4	86.3
Kook Creek (logged)	10.3	15.0	11.1	13.9
Crab Creek (unlogged)	56.8	21.8	19.6	39.3
Crab Creek (logged)	58.8	24.3	27.5	44.7
Freshwater Bay (unlogged)	66.5	77.5	27.8	80.0
Freshwater Bay (logged)	91.0	80.6	0.0	90.5
Pavlof River (unlogged)	26.3	13.3	42.5	29.0

5. Mean percentage of pools was greater in the unlogged site at Kook Creek and lower at Freshwater Bay.
6. Mean percentage of instream velocity barriers was lower in the unlogged study site at Kook Creek.
7. Mean percentage of undercut banks was greater in the unlogged study site at Kook Creek.
8. Mean percentage of overhead cover was greater in the unlogged study site at Kook Creek.
9. Estimated numbers of coho salmon were lower in the unlogged study site at Crab Creek.

Unfortunately, because of the limited sample size (i.e. three areas with both logged and unlogged streams) general statements about the relationships of the parameters examined and logging activities cannot be made. It remains to be determined whether or not the differences indicated above are actually the results of logging activities or are merely normal occurrences that may be detected when comparing different sample sites.

The fact that statistically significant differences were detected, however, does tend to indicate that the short-term sampling techniques were valuable in quantifying parameters related to rearing fish populations and rearing fish habitat.

Additional evidence indicating the usefulness of the short-term survey techniques that were used during this study was provided by an analysis of correlations between various parameters. With the aid of a computer it was possible to produce correlation matrices that displayed the r-values obtained by comparing pairs of parameters. The data gathered during the logging studies permitted the correlation of fish, insect, and habitat parameters obtained from the seven study sites. Also it was possible to examine correlations between fish and habitat parameters obtained from the 15.24 m sample units contained within the seven study sites. The latter correlations were obtained from analysis of all of the sample units (n=138) combined, and from analysis of sample units contained within each of the study sites (n=19 or 20). A summary of the most significant correlations is presented in Table 19.

#### Rearing Dolly Varden in Montana Creek

Declining catch rates for Dolly Varden in the Juneau roadside sport fishery (Marriott et al., 1979) prompted an attempt to determine the status of rearing Dolly Varden in Montana Creek. The only previous work in this system involving rearing Dolly Varden was a single population estimate in the vicinity of the bridge on Mendenhall Loop Road. This work was done in August, 1978 and produced an estimate of 149 DV with a 95% confidence interval from 85 to 397 (Hubartt, 1979). The same area was trapped during the current study during the same time period and only three marked fish were recaptured precluding the calculation of a population estimate. The total number of Dolly Varden trapped in 1978 was 85, and the total number captured in 1979 was 50. The difference between numbers captured was not large enough to indicate whether population levels are changing.

Table 19. Summary of significant correlations between fish, insect, and habitat parameters.

Parameters Correlated	304.8 m Study Sites		
	Sample Size n	Correlation Coefficient r	Significance Level %
CDV and P	7	-0.40	<90
CDV and VB	7	-0.57	<90
EDV and VB	7	-0.78	95
XDV and VB	7	-0.81	95
CDV and C	7	-0.61	<90
CDV and C	---	---	---
EDV and C	7	-0.78	95
XSS and VB	7	0.78	95
CSS and C	7	-0.26	<90
CPSS and TT	7	-0.81	95
CSS and TT	7	-0.80	95
ESS and TT	7	-0.88	99
DSS and TT	7	-0.86	98
CPSS and SI	7	-0.97	99.9
CSS and SI	7	-0.94	99
ESS and SI	7	-0.89	99
DSS and SI	7	-0.85	98

	15.24 m Sample Units			Comments
	Sample Size n	Correlation Coefficient r	Significance Level %	
CDV and P	138	-0.26	99	
CDV and VB	138	-0.24	98	
CDV and C	138	-0.24	98	
CDV and C	20	0.65	99	Freshwater Bay-unlogged
CSS and C	20	0.60	99	Freshwater Bay-unlogged
CCT and VB	138	0.25	98	
CCT and VB	20	0.53	98	Crab Creek -unlogged

Key to Abbreviations:

- Fish parameters
- ( CDV = Total catch of Dolly Varden
  - ( EDV = Estimated number of Dolly Varden
  - ( XDV = Mean length of Dolly Varden
  - ( CSS = Total catch of coho salmon
  - ( CPSS = Mean catch per unit-effort of coho salmon
  - ( ESS = Estimated number of coho salmon
  - ( DSS = Density of coho salmon
  - ( XSS = Mean length of coho salmon
  - ( CCT = Total catch of cutthroat trout

Table 19. (Cont.) Summary of significant correlations between fish, insect, and habitat parameters.

Key to Abbreviations:

	(	P = Percent pools
Habitat parameters	(	VB = Percent instream velocity barriers
	(	C = Percent overhead cover
Insect parameters	(	TT = Total number of insect taxa
	(	SI = Shannon-Weaver Diversity Index

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Three additional areas were trapped during the current study but trapping results only allowed the calculation of two population estimates. The only yardstick that can be used to gauge whether these estimates are high or low is the mean value of estimates of rearing Dolly Varden numbers that have been recorded to date. That mean value is currently 525 with a standard deviation of 398 and is derived from a total of 43 estimates of rearing Dolly Varden numbers. With respect to this figure the estimates obtained in the Montana Creek watershed are all within one standard deviation with the Loop Road estimate falling below the mean, the Beaver Slough estimate falling very close to the mean, and the McGinnis Creek tributary estimate falling above the mean. This comparison tends to indicate that the population levels of rearing Dolly Varden are neither exceptionally high nor exceptionally low. A much more extensive study would be needed to determine where populations levels are with respect to the carrying capacity of the system.

#### Aquatic Insect Sampling

In general the results of sampling aquatic insects in the Montana Creek watershed were similar to sampling that had been done in other freshwater streams in southeast Alaska. One notable exception did occur, however. This was the appearance of large numbers of the genus Empididae in the benthic samples collected in the tributary to McGinnis Creek on July 26, 1979. A total of 114 individuals were collected which comprised 37.1% of the total sample (see Table 11). Reasons for this occurrence are unknown.

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Prepared by:

Approved by:

Dennis Hubartt  
Fishery Biologist

Rupe E. Andrews, Director  
Sport Fish Division

Mark C. Warner, Ph.D.  
Sport Fish Research Chief

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